



# Exploring seasonal variability in stratification with Ocean Observatories Initiative Ocean Data Labs

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**Take home message:** Instead of static textbook images, we use interactive widgets of real data from the Ocean Observatory Initiative (OOI) to cement understanding of ocean stratification including drivers and variability, while also allowing students to grapple with data gaps, representation, and interpretation. This data lab and instructor guide will soon be freely available online through ***datalab.marine.rutgers.edu*** along with the rest of the collection.

**Learning goals of lesson:** Through active participation in the data lab, students should be able to

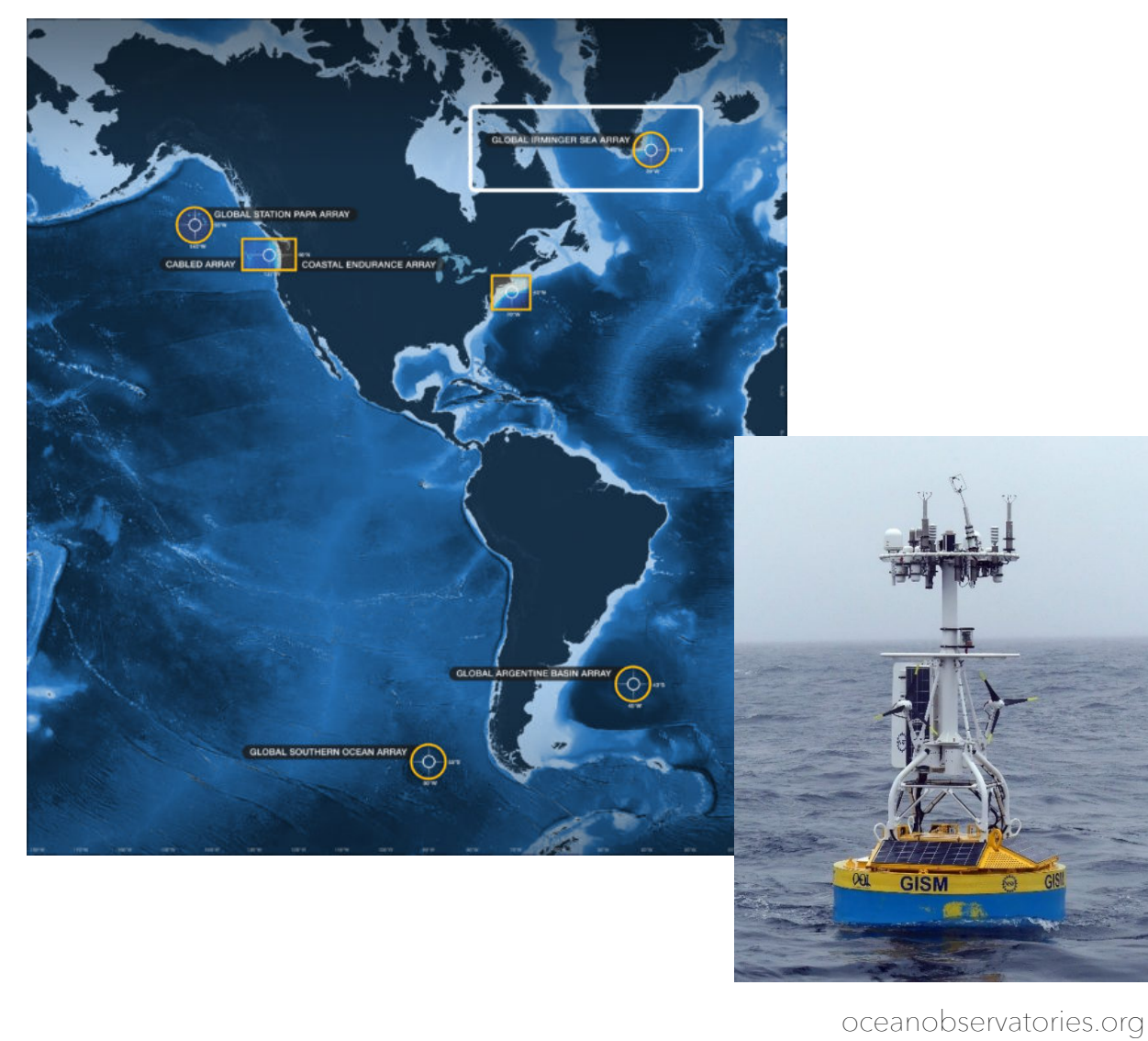
- **Read/draw time-series and depth profile** plots of temperature, salinity, and density and **communicate** that information in words
- **Synthesize** atmosphere and ocean data to describe how and why stratification varies seasonally (and interannually)
- **Hypothesize** how physical mixed layer processes relate to primary production and large scale circulation

**Appropriate grade level:** Undergraduate **introductory** oceanography. Could be extended for upper level students.

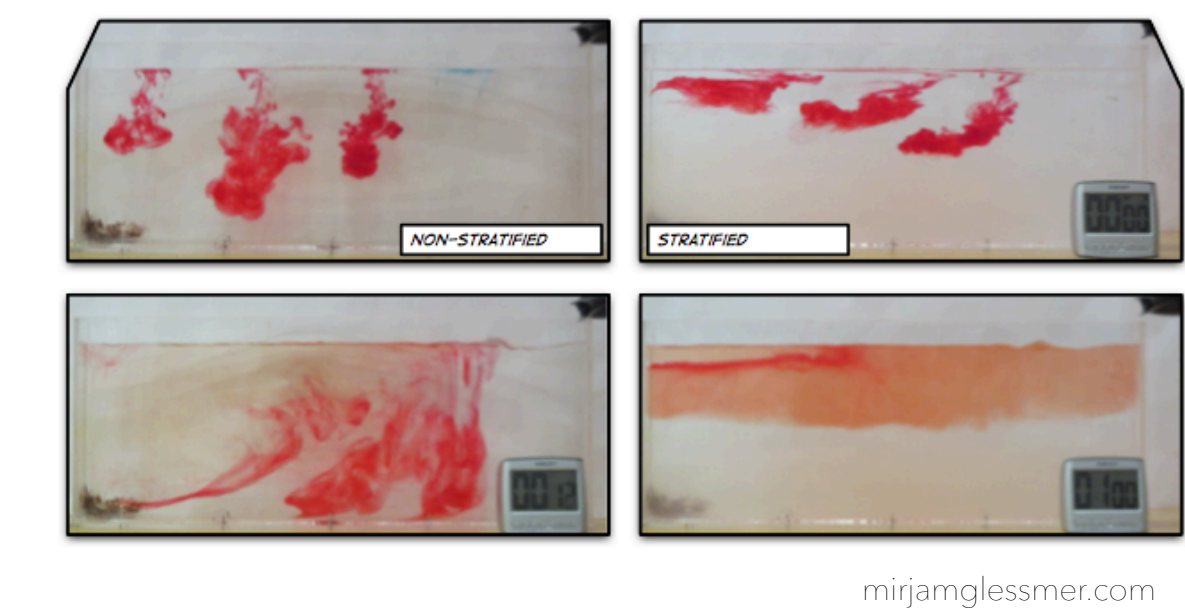
## Invitation

You could hook your students in a number of different ways.

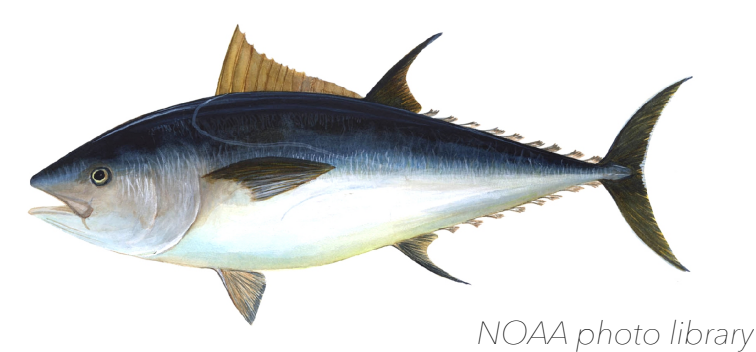
Discuss the OOI's, global coverage, and technology used to capture timeseries data.



Do a tank demo in class that allows students to see the interaction between wind and stratification first hand.



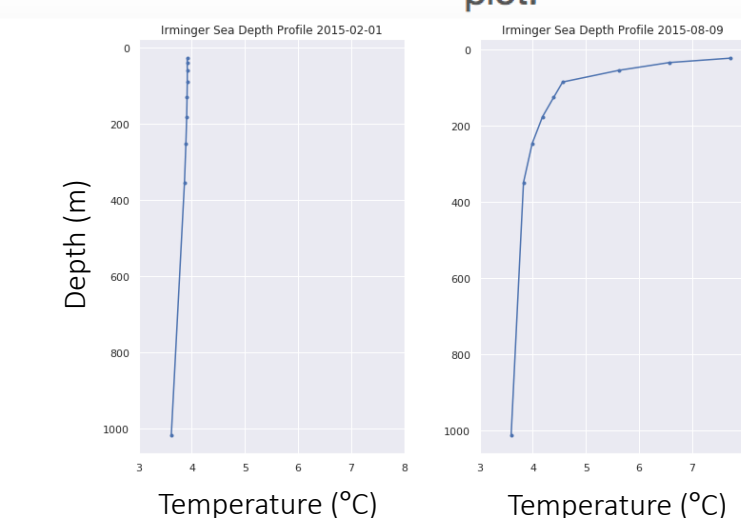
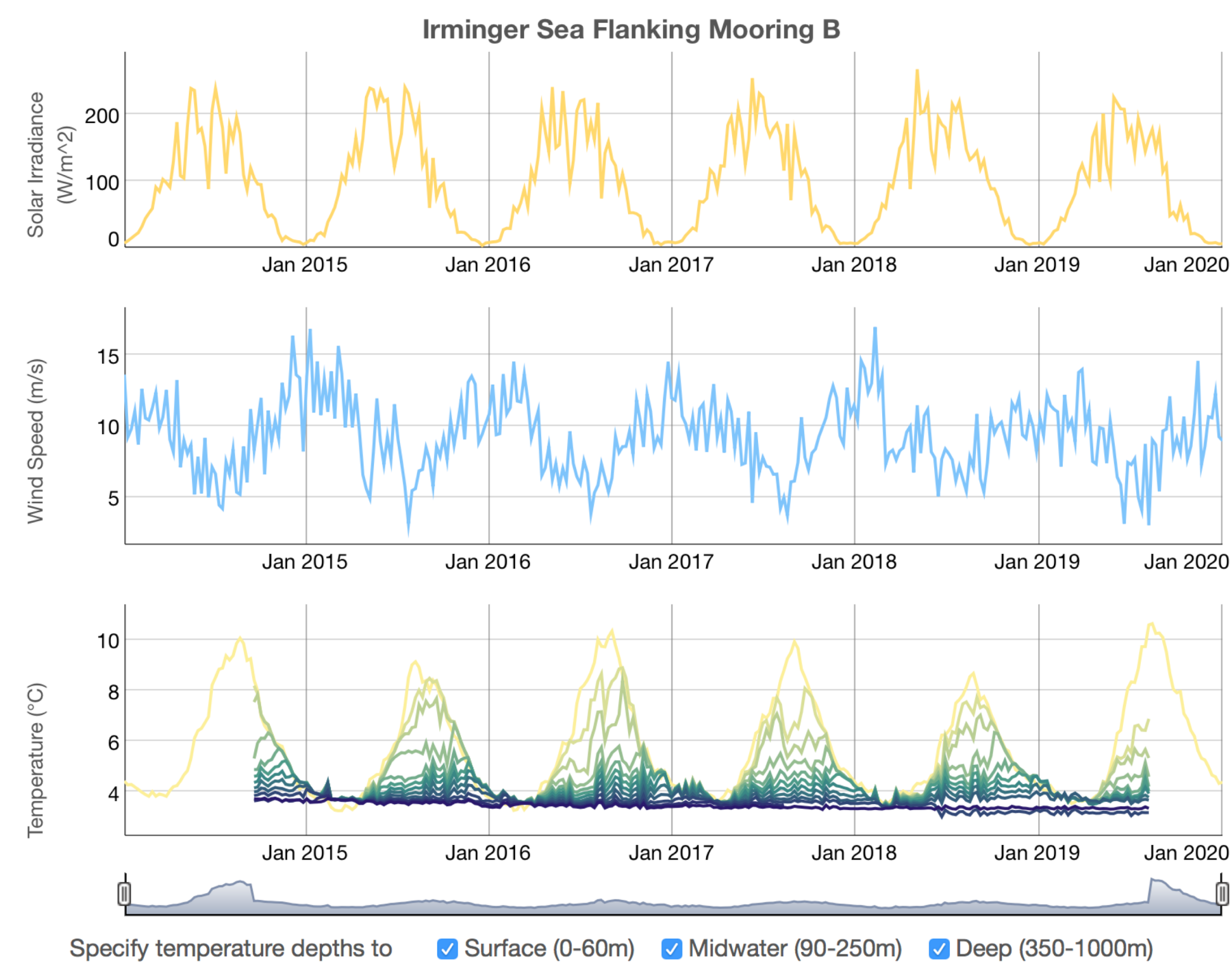
Explain how North Atlantic fisheries are tied to primary production controlled in part by stratification.



NOAA photo library

## Exploration

How and why does stratification in the North Atlantic Ocean vary? Use the widget to explore data from the Irminger Sea.



Interactive widget of data from the Irminger Sea that students explore while answering the example questions below. Students will be able to scroll through the data and a pop-up of the temperature depth profile at that time will appear.

### Orientation Questions

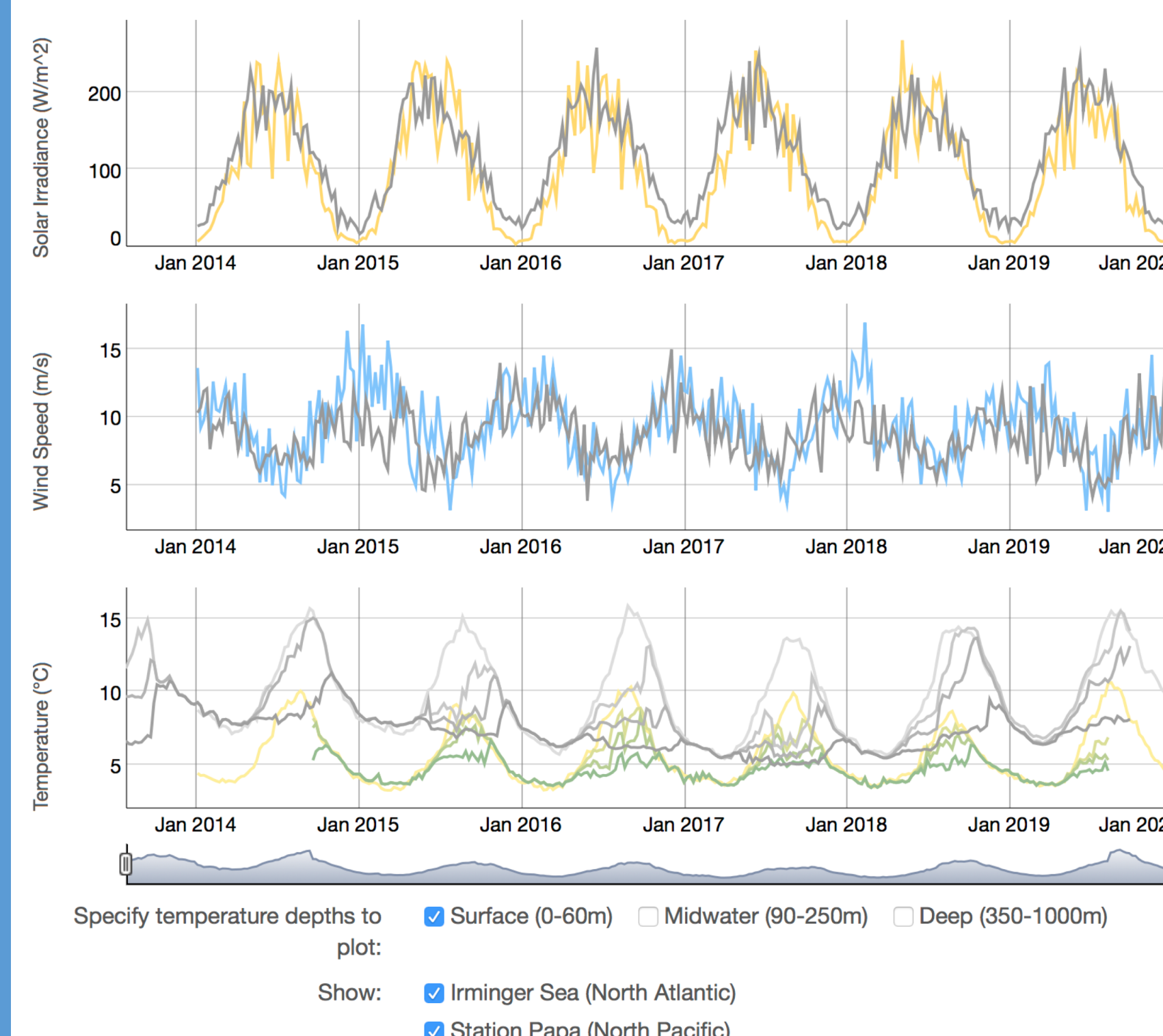
- What oceanic or atmospheric variables can you investigate in these graphs? What are their units?
- How were these data collected?
- What is the range in values (both x and y axes)?

### Interpretation Questions

- Can you identify the mixed layer depth at various different points in the year using the data provided here?
- What questions do you still have about what drives seasonal variability in stratification?

## Concept Invention

Develop a simple conceptual model of the controls on surface mixing in the ocean, and verify it at Station Papa.



Interactive widget of irradiance, winds, and temperature data from Irminger Sea and Station Papa. Students can change the time scale and toggle on and off data as they compare and contrast the two stations. Papa stays stratified year round while Irminger mixes, thus nicely tying into discussions of thermohaline circulation. The interannual variability is also interesting.

### Orientation Questions

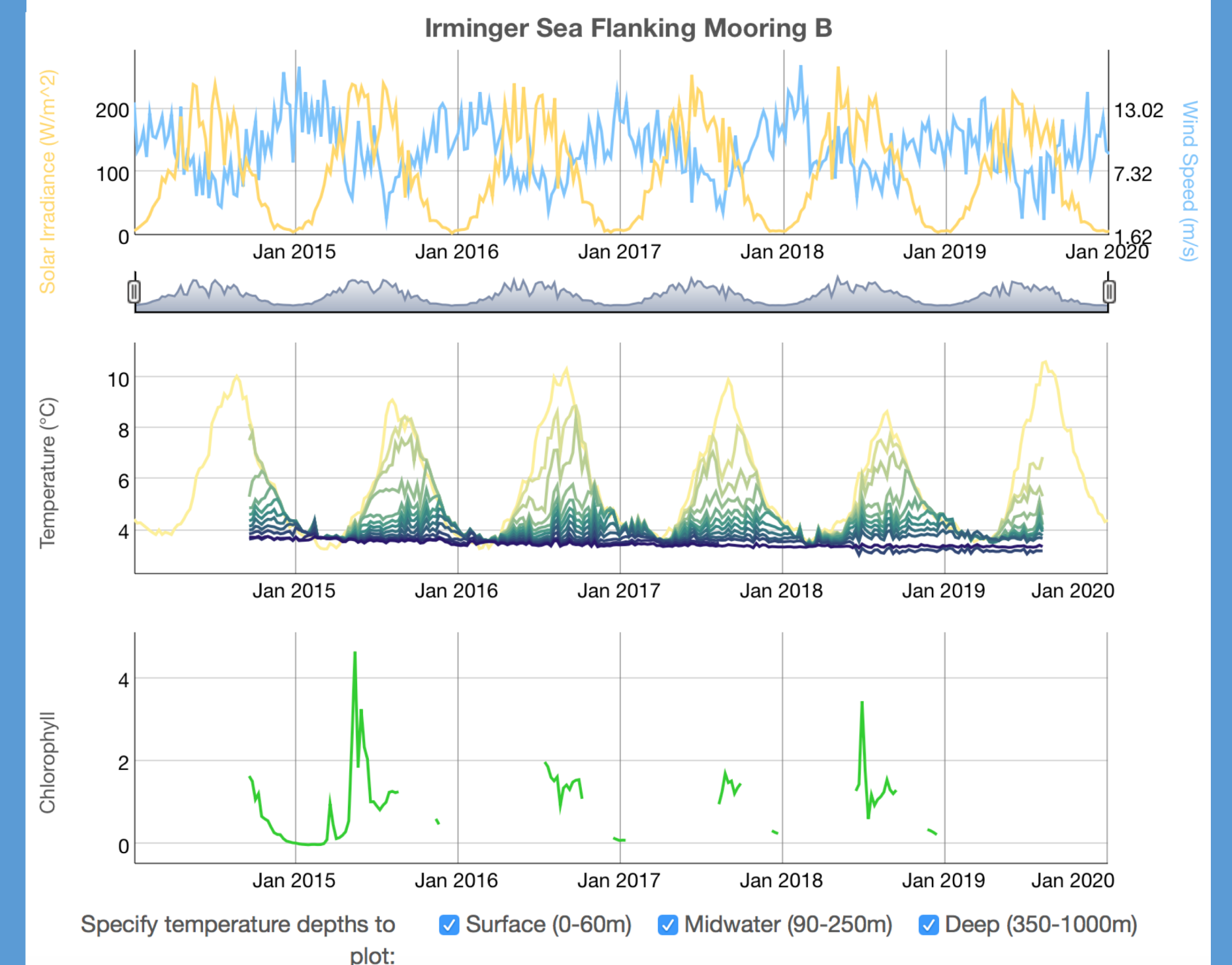
- Across what time periods are you able to observe oceanic or atmospheric variables in these graphs?
- What is the overall range of wind speeds at this site for each season? How about for solar irradiance?

### Interpretation Questions

- Is there a time in the year when the upper 1000 m are fully mixed at Irminger? At Papa?
- Are the patterns that you observe here consistent with your conceptual model?

## Application

How do mixed layer depth dynamics impact primary production?



Interactive widget of irradiance, winds, temperature and chlorophyll data from the Irminger Sea. Students can change the time scale and toggle on and off temperature measurements from different depths as they answer questions like the ones below. This also leads nicely to other OOI labs on production.

### Orientation Questions

- Do you observe any patterns? If so, what were the patterns and for which variables?
- At what time of year is the mixed layer the deepest?
- Why are there gaps in the data?

### Interpretation Questions

- Does there seem to be a connection between chlorophyll variability and mixing processes/mixed layer depth at this site?
- Does this align with your understanding on the limitations of primary production?

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